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LIQUID CRYSTAL DISPLAY DEVICE AND METHOD OF FABRICATING THE SAME

The present invention claims the benefit of Korean Patent Application No. 2003-0042729 filed in Korea on Jun. 27, 2003, which is hereby incorporated by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a display device and a method of fabricating a display device, and more particularly, to a liquid crystal display (LCD) device and a method of fabricating an LCD device.

2. Discussion of the Related Art

In general, an LCD device includes two substrates that are spaced apart and facing each other, wherein a liquid crystal layer is interposed between the two substrates. Each of the substrates includes an electrode, wherein the electrodes of each substrate also face each other. Accordingly, when a voltage is supplied to each of the electrodes, an electric field is induced to the liquid crystal layer between the electrodes. Thus, alignment of liquid crystal molecules of the liquid crystal layer are changed by varying the intensity or direction of the electric field, thereby varying light transmissivity of the liquid crystal layer and displaying an image.

FIG. 1 is a perspective view of an LCD device according to the related art. In FIG. 1, an LCD device has upper and lower substrates 50 and 10 that are spaced apart from and facing each other, and a liquid crystal layer 70 is interposed between the upper substrate 50 and the lower substrate 10. The upper substrate 50 may commonly be referred to as a color filter substrate, and the lower substrate 10 may be commonly referred to as a TFT array substrate.

The upper substrate 50 includes a black matrix 52, a color filter layer 54, and a common electrode 58 disposed along an interior surface (i.e., side facing the lower substrate 10) of the upper substrate 50. The color filter layer 54 corresponds to openings formed within the black matrix 52, and includes three sub-color filters of red (R) 54a, green (G) 54b, and blue (B) 54c. In addition, the common electrode 58 is formed on the color filter layer 54 and is formed of a transparent material.

In FIG. 1, at least one gate line 16 and at least one data line 26 are formed on an interior surface (i.e., side facing the upper substrate 50) of the lower substrate 10, wherein the gate line 16 and the data line 26 cross each other to define a pixel region P. A switching element, such as a thin film transistor (TFT) T, is formed at the crossing point of the gate line 16 and the data line 26, wherein the TFT T includes a gate electrode, a source electrode, and a drain electrode. A plurality of the TFTs is arranged in a matrix configuration to correspond to other crossings of gate and data lines 16 and 26. In addition, a pixel electrode 32 is formed in the pixel region P, and is connected to the TFT T. The pixel electrode 32 corresponds to the sub-color filters 54a, 54b, and 54c, and is formed of a transparent conductive material, such as indium-tin-oxide (ITO), that has a relatively high light transmissivity.

FIG. 2 is a flow chart of a fabrication process of an LCD device according to the related art. In FIG. 2, a step ST1 includes preparation of a lower substrate having TFTs and pixel electrodes, and an upper substrate having a color filter layer and a common electrode.

Next, a step ST2 includes formation of first and second alignment layers on the pixel electrode and the common electrode, respectively. The formation of the first and second

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alignment layers includes coating thin polymer films, such as polyimide, on the pixel and common electrodes, and rubbing the thin polymer films. The thin polymer films must have uniform thickness, and the rubbing process must be performed uniformly along the thin polymer films. Accordingly, an initial orientation of liquid crystal molecules is determined by the rubbing process.

Then, step ST3 includes forming a seal pattern on either the lower substrate or the upper substrate, thereby providing a cell gap between the lower and upper substrates to allow for injection of liquid crystal material between the lower and upper substrates. In addition, the seal pattern prevents the injected liquid crystal material from leaking through the seal pattern. The seal pattern is commonly fabricated using a screen-printing method or a dispensing method that includes a mixture of thermosetting resin and glass fiber.

During step ST4, spacers are sprayed on one of the lower and upper substrates using a spacer spraying method to maintain a uniform gap between the lower and upper substrates. The spacer spray method can be divided into two different types, such as a wet spray method that includes spraying a mixture of alcohol and spacer material, and a dry spray method that includes spraying spacer material alone.

In FIG. 2, the seal pattern and the spacers are formed on different substrates. For example, the seal pattern may be formed on the upper substrate that has a relatively flat surface, and the spacers may be formed on the lower substrate.

During step ST5, the lower and upper substrates are aligned and are attached to each other along the seal pattern. An alignment accuracy of the substrates is determined by an alignment margin, wherein an alignment accuracy of several micrometers is required since light leakage occurs if the substrates are misaligned beyond the alignment margin.

During step ST6, the attached substrates are divided into unit cells using a cell cutting process. The cell cutting process includes a scribing process that forms scribe lines on a surface of the substrate using a diamond pen or a cutting wheel of tungsten carbide, wherein a hardness of the diamond pen or cutting wheel is higher than a hardness of the substrate, which is formed of glass. Then, a breaking process is performed to divide the unit cells by applying a force.

During step ST7, a liquid crystal material is injected between two substrates of each individual unit cells using a vacuum injection process, wherein each unit cell has an area of several square centimeters and a cell gap of several micrometers. The vacuum injection process makes use of a pressure difference between an interior of the unit cell and an exterior of the unit cell.

Then, after completing the vacuum injection process, the injection hole is sealed to prevent leakage of the liquid crystal material. In general, an ultraviolet (UV) curable resin is injected into the injection hole using a dispenser, and ultraviolet light is irradiated onto the resin to harden the resin and seal the injection hole. Next, polarization films are attached onto outer surfaces of the unit cell, and a driving circuit is connected to the unit cell using an attachment process.

During the above processes, special standardized spacers are used as the spacers. However, there are many limitations in spraying the spacers. In addition, it is difficult to obtain a uniform cell gap for large-sized substrates. Thus, patterned spacers have been developed, wherein the patterned spacers may be formed on the upper substrate (i.e., color filter substrate) and/or the lower substrate (i.e., TFT array sub-